The University of Arizona
MATHEMATICS

Fall 2002

A VIEW FROM THE CHAIR

Nicholas Ercolani
Department Head and Professor of Mathematics

In this Issue

Recent successes of popular books and movies about mathematicians suggest that a growing portion of the general public is interested in mathematics and those who create it. This issue of our newsletter features several articles related to this theme.

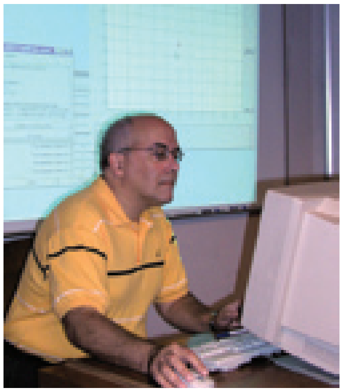
Bill Faris, last year's Colloquium Chairman, writes about a recent production of "Proof" by the Arizona Theatre Company and interactions of the Director and cast with Mathematics faculty. Alain Goriely's article provides a glimpse into a mathematician's process of discovery in trying to understand the "crack of a whip". This work was featured in the Editor's Choice section of a recent issue of Science as well as being the subject of an interview on National Public Radio's Weekend Edition. We also have an article by David Gay on our Mathematics Education group's MAPPS program which is designed to involve parents in their children's mathematics education. For many parents this program has also opened a path for rediscovery and extension of their own mathematical experiences.

At the center of this newsletter are articles by Bruce Bayly, Associate Head for the Undergraduate Program, and Bill Vélez, the Department's industrial liaison, which provide an overview of activities and opportunities for our undergraduate math majors.

In addition, this issue contains an article by Arlo Caine describing his experiences as a first year graduate student as well as one by Ted Laetsch relating the professional experiences of current and former colleagues in the Department's unique Teaching Postdoc Program. In response to the appeal in our last issue for alumni to describe their post-academic evolution, Heinz Roitner, an Applied Mathematics graduate alumnus, has written about his work at Siemens Austria. I hope that we will hear from more alumni about career experiences in future newsletters.

Starting in this issue, and to become a regular feature, is a section on profiles of new members of our department as well as of faculty who have recently become Emeritus Professors.

Finally, I would like to draw your attention to the Wish List appearing on page seven of this issue. Recent budget cutbacks have placed a significant financial strain on the Department. We have steadfastly resisted cutting back on our fundamental programs and the people who make them work. The burden of the cuts has therefore fallen on our material resources. While we have been able to bear this in the short term, we are



starting to feel the impact of the degradation and ultimate loss of these resources. The Wish List indicates what some of the most critical needs are, along with their respective costs.

Our students have benefitted from the generosity of alumni and benefactors who have contributed to our scholarship and outreach programs and we greatly appreciate this support. We hope the accompanying list will assist in providing a focus for those of you who want to identify other concrete ways to contribute to the preservation of mathematical training and education in Arizona.

Contact us at: http://www.math.arizona.edu/~mcenter/alum

Proof *Director Samantha Wyer and actors Traber Burns and Angela Pierce*

Mathematics and Theater

by William Faris

Samantha Wyer, Director of the Arizona Theatre Company's production of ***Proof*** was the speaker at the Mathematics Colloquium, January 31, 2002. She brought along two actors from the cast: Traber Burns and Angela Pierce. In ***Proof***, Burns played the role of the mathematician father, and Pierce, who fears that she has inherited his mental illness, portrayed his daughter.

The colloquium began with background about the production and with an explanation of how the director and actors prepared for it. This led to a lively general discussion of the play and its implications.

The author of ***Proof***, playwright David Auburn, wanted to create a drama about a family, and chose a theme involving mathematics and mental illness. This combination also appears in the book and film ***A Beautiful Mind*** and in the film ***Pi***. One can ask why this theme is popular. The reason is clearly dramatic contrast. Most mathematicians are sane people who work hard but enjoy what they are doing. However, there is theatrical tension in the situation of someone (like John Nash in ***A Beautiful Mind***) who does high level work with his mind and also grapples with insanity. In a similar way, the play ***Breaking the Code*** (presented by the University of Arizona Theater some years ago) exploits a contrast between the professional and personal lives of the mathematician Alan Turing.

...the daughter may have inherited genius or insanity, but presumably not both.

The play ***Proof*** has a somewhat different dynamic, in that the daughter may have inherited genius or insanity, but presumably not both. It is the uncertainty about this question that provides the suspense. The play does not give much sense of the content of mathematics, but it does try (largely successfully) to portray the personalities and social interactions of mathematicians. The director and actors had to figure how to put this on the stage, and the colloquium helped give an idea of how they achieved this.

This meeting of the worlds of mathematics and theater was part of the regular Mathematics Colloquium series, but several people put in extra effort to make it work. In particular, Joe Watkins and Olga Yiparaki made important contributions. Also, Joceline Lega took nice photographs.

Mathematics Colloquium Chairman Bill Faris

Mathematics in a Digital World

by Heinz Roitner

Applied Math Alumnus involved in digital communication engineering

This personal account relates my experiences as an applied mathematician working with a group of radio communications engineers at Siemens Austria, Vienna, and is a reflection on my metamorphosis, personally and professionally, from academia to industry, and will give you the flavor of my current work.

After graduating with a Ph.D. from the Program in Applied Mathematics at the U of A in 1991 (advisors: D.W.McLaughlin and N.Ercolani) I held various teaching appointments in Germany and Austria. Eventually I joined Siemens Austria where, by good luck, I became part of a group specializing in programming digital signal processors (DSPs) for radio communication systems. Siemens is the biggest industrial employer in Austria (which is about the size of Arizona). In particular, its program and system engineering (PSE) branch is the biggest high-tech workplace in Austria with some 4000 employees. Siemens Austria also has a supervising and training role for recently established Siemens outposts in countries like Croatia, Bosnia, Slovakia and Romania.

...working with a group of radio communications engineers at Siemens Austria, Vienna, and is a reflection on my metamorphosis, personally and professionally, from academia to industry...

My successful handshake with the radio communication engineers can be attributed to several factors: on my side, openness to following a completely new path and the effort to improve communication and interaction skills; on the other side, the willingness to let in a person already specialized quite deeply in a different subject. At Siemens Austria, people of different backgrounds have to collaborate in industrial teams and communication is critical to the point of consuming about half your working time. Also, a proficiency with standard computing tools is expected.

I happened to walk in on a project where a microwave identification device (e.g. for car manufacturing) was to be developed from scratch, so I gained first-hand experience with the system architecture as well as the structure of software designed for specific processors. DSPs for real-time applications are typically still programmed in a processor-specific assembler language.

In modern radio communication systems, data are given a certain redundancy before transmission, in order to enable error detection and, possibly, error correction at the receiving end. For our system, we used a downsized version of an encoder-decoder known from mobile phone systems, but the error correction algorithm of such decoders always makes assumptions about the type of errors which have occurred. If these assumptions are not met by the real transmission channel, transmitted bit sequences may be corrected to a different bit sequence than that which was sent. We had to determine the probability of such "incorrect corrections."

A program written by a colleague experimentally determined the probability of such events for a given number of bit errors in a certain bit sequence. I observed that the number of such bit errors itself is Poisson-distributed. By multiplying, we were able to determine the overall probability of such events. It turned out that it is good enough for speech transmission, but not for data transmission where a single bit error can lead to disaster. (By the way, a full understanding of channel coding techniques comes only with a heavy dose of abstract algebra polynomials over finite fields).

As many graduates of math departments will likely seek employment in industry, I would like to conclude with a few suggestions to faculty:

- offer some courses and labs which above all reward team achievement; additionally, individual contributions to the team effort may be graded by team members.
- offer some courses and labs where a significant use of state-of-the-art technology is required.
- illustrate your courses with applications drawn from current technological hotspots, such as computer science and telecommunications.
- talk to and connect to those engineers who are actually inclined to apply mathematical methods in their professional lives; invite them to give a talk to students.

Whips! What? Where? How? but mostly Why?

by Alain Goriely

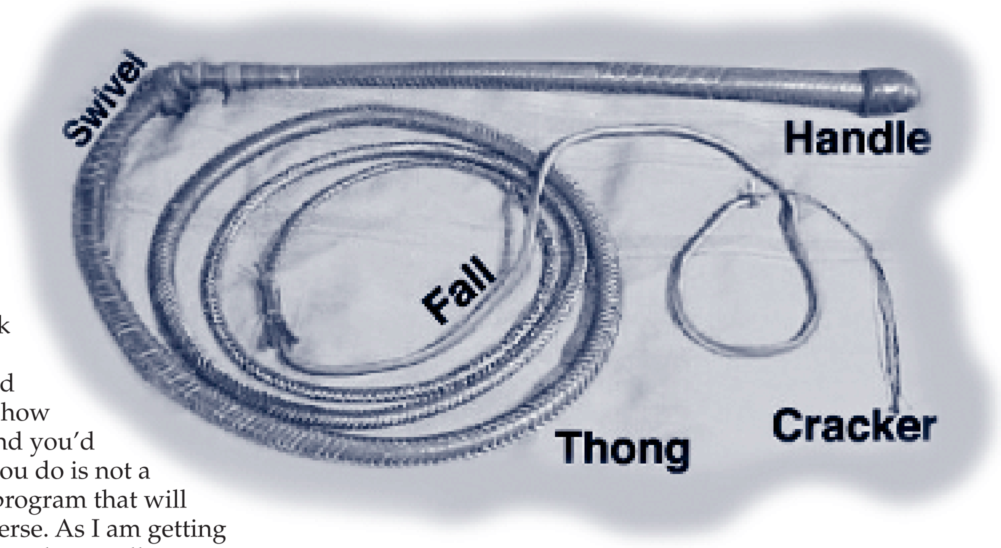


Figure 1: An 8-foot Australian bullwhip

"So, Professor Goriely, how did you get interested in whips?"

I am sitting in a funny cubicle full of wires and high-tech equipment in the Paris studio of BBC as I'm asked the question yet again. Every single journalist I have talked to in the last few months has asked me that same question, soon followed by: "Is there any application of your study?" Strange! As soon as you work on anything that does not sound utterly boring with well-known acronyms attached to it, you'd better have a good story about how you became interested in that problem. And you'd better have a clear justification that what you do is not a silly, harebrained hobby, but part of a big program that will eventually unlock the mystery of the Universe. As I am getting ready to give the standard answers, the same that I will eventually massage into a grant proposal, I take a few seconds to reflect on my true motivation and realize I can't really quite find one besides the obvious: this is a neat problem! So, before I finish my interview, let me tell you more about whips and let you be the judge.

What makes the whip crack? I still remember having heard on the radio as a youngster that the crack is a sonic-boom, not unlike the sound of a supersonic bullet, created when the tip of the whip travels faster than the speed of sound. For the next twenty years I took this datum for granted and did not think much of it until I studied wave propagation on elastic filaments. Under the typical regularity, homogeneity, symmetry, reliability, uniformity, proportionality, and tractability assumptions, waves will travel at constant speed and provide us with neatly packaged solutions ready for publication. This simple observation, together with experimental evidence showing that parts of the cracking whip travel at supersonic speed, lead naturally to a second question: how does the tip of a whip accelerate to supersonic velocities? The initial impulse given to a whip is of moderate velocity, usually less than a tenth of the speed of sound, and within a few meters this impulse moves to velocities two or three times greater than the speed of sound. Experimental observations indicate acceleration in excess of 50,000 times the acceleration of gravity. What are the physical ingredients necessary to produce such a tremendous acceleration? And why do we care? Together with Tyler McMillen (a courageous member of the Program in Applied Mathematics), we have tried to answer these questions.

...the goal of our study is to understand fundamental phenomena appearing at the microscopic level...

To avoid confusion, and before I am the victim of more insidious snickering from my colleagues, I would like to clarify that the whips we are studying are long, tapered, and single-threaded such as the bullwhip whose sole purpose is to produce a distinct crack, and NOT (I repeat NOT!) those of poor scientific interest used for torture and other perverse activities which are instead short, bulky, knotty and multi-threaded, such as the infamous "cat-'o-nine-tails" used by the US Navy until the sixties. The main modern development of whip technology is associated with the European conquest of the American West and Australia where small whips with short handles were needed for open ranching. Nowadays, the whip has lost most of its commercial use despite having become a mythical object for Hollywood entertainment at the hands of Xena, Indiana Jones, and Zorro. The art of the whip is kept alive by a few dedicated craftspeople and whip enthusiasts, a strange blend of western aficionado, martial art fanatics, and minor entertainers.

At a scientific level, whips have been considered as a frivolous topic not worthy of true academic recognition and only a handful of experimental works have been performed all showing maximum tip velocity in excess of 2 to 3 times the velocity of sound in the air.

So where does that leave us? Clearly, somebody must have cracked open the problem years ago and there must be a satisfactory treatment of the problem hidden away in an old book somewhere.

To our surprise and delight, we could not find any real answers to our questions. Various theoretical studies on the dynamics of whips have reached seemingly mutually exclusive, contradictory results, with no apparent reconciliation. Most of these formulations involved posing the propagation of a whip wave as a one-dimensional energy problem. Naively, as a wave travels down a whip, the mass actually traveling decreases, and to conserve energy the wave speed must increase to infinity. This is the "Energy Mantra" regularly practiced by scientists to explain away every single phenomenon with a swift wave of the hand. If instead one believes in the "Linear Momentum Mantra," a marginal but equally valid practice, the speed of the tip should remain constant. Clearly, the speed of the tip does accelerate as the wave travels down the length of the whip, but it does not approach infinity, even if it does taper to zero radius. These formulations, while interesting, all suffer from the same flaw, which is the failure to account for the shape of the whip. One cannot simply assume the shape and solve for the velocity; the cracking whip obeys physical laws coupling its dynamics to its shape.

How does one crack a whip? As I found out, whips can be dangerous for their users. The long thong and cracker under untrained hands can easily lash back at one's face or rip one's pants leaving embarrassing scars. It turns out that the most elegant and efficient way to crack a whip consists of moving it so as to create a loop that travels and accelerates to the end of the whip.

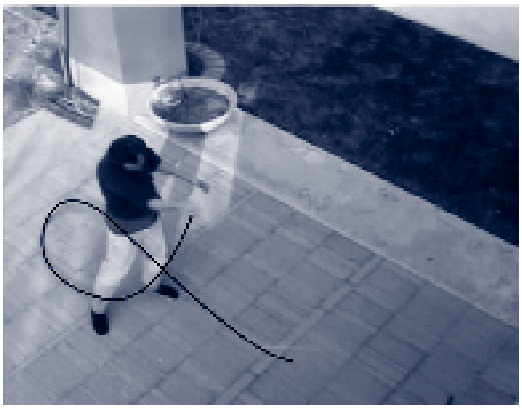


Figure 2: *A balding Prof. Goriely performing a classic overhead crack in his poorly maintained backyard (with a superimposed curve on the fast moving whip.)*

At this point in our study, we finally knew enough about whips to model them and formulate some decent scientific questions; the key feature being the propagation of a loop along a tapered rod with one end with controlled tension (the handle) and one free end (the tip). From a mathematical perspective, the simplest model that describes the mechanically correct dynamics of a whip is a system of three partial differential equations of second order in time and arclength (running along the whip). The coefficients appearing in the equations such as mass and bending modulus are varying but known functions of the arc length. To make matters worse, the highest order derivatives include these functions, which leaves the nature of the PDE undefined. The general analysis of such system is a daunting task especially with mixed boundary conditions. We attacked the problem from three different perspectives.

First, we looked at the problem of tapering. It is well known in many fields that waves moving on a varying background can accelerate; for instance, one can think of the propagation of water waves arriving at shore where depth varies, or the propagation of optical pulses in fibers of varying physical properties. If we begin with a traveling loop solution along an ideal infinite rod slowly tapered, an asymptotic analysis of the conservation laws reveals that for most physical values, the speed of this traveling wave increases while its amplitude remains mostly constant. Propagation of similar loops is found in fly-fishing and in sperm motility (albeit in a highly viscous material).

Second, we analyzed the asymptotic shape of the whip as it cracks and discovered a self-similar solution that describes the formation of a singularity in the curvature of the whip as it extends. This type of singularity has also been observed experimentally and probably deserves further attention.

Finally, we studied the effect of boundary conditions and other physical parameters on the velocity of the tip by developing a dedicated numerical scheme that preserves all the known physical constants of the motion. This numerical analysis showed that a subtle combination of initial data, tapering, boundary conditions and extra motion of the handle during the crack is necessary to obtain the correct tip velocities. This is no surprise to people who actually crack whips and know that dexterity, accuracy, and a superb whip are necessary ingredients for the perfect crack.

In all, the whole experience had been great; from learning about whips through books and videos, practicing in my backyard, to modeling and eventually juicing interesting properties out of the PDEs; I wish I had more time to waste on these fun but unfundable projects.

“Professor Goriely! Are you there?” I hear the perfect British tone in my headphone and realize I was day-dreaming.

“Yes, absolutely,” I reply in my hesitant but characteristic Jean-Claude van Damme accent. What was the question again? Oh yes, the applications of my “theory.”

“Well, you see, the analysis of whip dynamics is of crucial importance and the goal of our study is to understand fundamental phenomena appearing at the microscopic level such as information propagation along DNA molecules and the way elastic waves propagates in biological systems, other applications include ...”

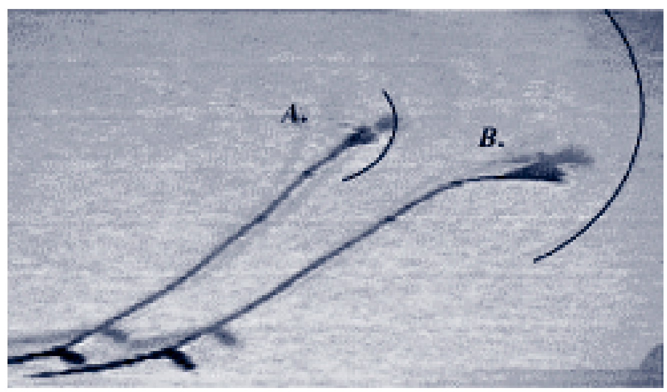


Figure 3: *High-speed digital shadowgraphs of a cracking whip and its sonic boom. The time interval between the 2 pictures is 111µs. The solid lines are superimposed over the shock waves. The velocity at the time of the crack was Mach 2.19. (Photo courtesy of A. Krehl.)*

To know more about whips:

Visit the bullwhip website at www.bullwhip.org

Listen to Prof. Goriely's interview
with Scott Simons on NPR weekend edition
http://www.npr.org/programs/wesat/features/2002/june/whip

Or download the Physical Review Letters article:
“The Shape of a Cracking Whip” at **http://prl.aps.org**

What Can You Do With Mathematics Besides Teach It?

by William Yslas Vélez

Many of our undergraduate mathematics majors have had the experience of working on several projects before they graduate, projects that allow them to give a rich and complex answer to this question. Undergraduate Teaching Assistantships, Research Experiences for Undergraduates, and Summer Internships in Industry, Government Laboratories and other universities are all part of the experience of many of our undergraduate students.

Not only are these positions rich in intellectual activity, but these paid positions also help the students fund their undergraduate studies. It is not at all unusual for a student to have participated in all three types of experiences before they graduate with their undergraduate degree.

Undergraduate Teaching Assistantships (UTA) were instituted in the department two years ago and carry a stipend of $1250 per semester. A student who has a UTA works with one of the faculty in the teaching of a course. The duties of a UTA are worked out between the faculty member and the UTA. UTAs will run problem sessions for the students in the class, perhaps grade some homework, or help the faculty in developing some of the material for the class. There is nothing like teaching someone else to really learn. Being a UTA is a great experience for those students who will do some teaching in the future. Here is the website that describes this position: **http://www.math.arizona.edu/~mcenter/research/UAMAZ.html**

Many of our undergraduate mathematics majors have had experience working on projects that allow them to give a rich and complex answer to this question.

Many students in the department are supported through the **Research Experiences for Undergraduates** program in the department. These students are supported through funds from the VIGRE grant. An Undergraduate Research Assistant (URA) earns the same stipend as a UTA. Faculty members propose a topic and students work on this project for a semester, for the academic year, or during the summer. The topics that students work on is as varied as the interests of the faculty. The web site mentioned above contains more information about these positions. In particular, applications forms for these positions can be downloaded from this website.

Summer Internships for mathematics majors are also a popular choice for many of the undergraduate students. Many universities, through funds from the National Science Foundation, support small groups of undergraduates, who oftentimes work on a pre-determined theme for that summer. The Mathematical Association of America maintains a website that contains a listing of these summer programs: **http://www.maa.org/students/reustuff/pages/REU.html**

The summer internships mentioned above are focused on mathematical topics, but many of our undergraduates find summer employment in other areas. It is gratifying to see the substantial number of our undergraduate mathematics majors that either have double majors, or else their minor is so strong that they can apply to participate in a summer internship in another field of study. Their knowledge of computer science helps many UA mathematics majors find summer employment in industry, government laboratories and bio-tech firms. UA mathematics majors are seen in biology, chemistry and physics projects all over this country. Several of the undergraduate mathematics majors are employed through the Undergraduate Biology Research Program on campus: **http://www.blc.arizona.edu/ubrp**

An undergraduate student who completes his/her degree in our department has not only been afforded the opportunity to study mathematics at a deep level but there has also been that unique opportunity to learn about the profession of being a mathematician. Mathematicians sometimes teach (UTA), they spend a great deal of their time creating new mathematics (URA) and they find themselves applying mathematical thinking and techniques to solve real problems (summer internships). An undergraduate degree in mathematics at the UA is a real introduction to the profession of the mathematician. **In the words of Nathanial Blair-Stahn, one of our undergraduate math majors:**

I will be graduating with a B.S. degree in mathematics in December 2002 from The University of Arizona. Over the past two and a half years, I have had the opportunity to participate in both the UTA and URA mathematics programs, as well as to gain experience with real-world applications of mathematics in summer internships. I have learned a great deal from all three of these experiences, and they have exposed me to a range of possibilities for the direction I can take with my mathematical career.

As a UTA, I held weekly review sessions for a calculus course in which I would review important or difficult material *with the students as well as help them work through specific problems. Getting up in front of the students required me to think on my feet and helped give me a sense of what it takes to teach mathematics. I also had to work in the algebra/trigonometry tutoring room for a few hours per week. This gave me additional experience in trying to help people understand a concept while avoiding merely giving away the answer.*

I also worked as a URA for a total of one summer and one semester. I met my sponsoring professor, Dr. Kelly Weiand, through the Undergraduate Research Seminar, which is a weekly lecture series designed to introduce students to faculty members with projects that they would like to work on with students. The project I worked on involved random matrices, and – with the professor's guidance – I needed to learn a little bit of background information before I could really get started. Once I did, much of my time was spent simply trying to figure out how to approach the problem in a way that would yield any meaningful results. Eventually we did make progress, and we actually ended up with some previously unknown results. Aside from gaining experience in problem solving and mathematical thinking, the most valuable aspect of the project to me was having to write a report describing the findings of the research.

In addition to these university-sponsored programs, I spent the summers of 2001, 2002 as an intern at Sandia National Laboratories in Albuquerque, NM. I worked in the field of cryptography. My undergraduate courses did not include this topic, but my mathematics background allowed me to understand the ideas well enough to write computer programs to implement cryptographic algorithms. Most of the work involved computer programming, and in fact, I had to learn how to program in C the first year I was there because I had previously only programmed in Java. I learned a lot about cryptography during my time at Sandia, and the experience showed me some of the options I might have for applying my mathematical knowledge professionally when I complete my undergraduate studies.

The department wants more of its undergraduates to participate in all of these activities. **For the undergraduate who is reading this article we urge you to visit these websites and to talk to your advisor about the opportunities that exist.**

We encourage you to not only stop by the undergraduate mathematics office but also to visit the UA career services center: **http://www.career.arizona.edu/students**. Career Services provides a great deal of information to help the student in many ways.

For the professional who is reading this article we urge you to think about hiring our undergraduates as interns. The department has created the position of industrial liaison for the express purpose of increasing the number of mathematics students who choose to apply their mathematical skills to industrial problems.

This year's industrial liaison is Dr. William Yslas Vélez **(velez@math.arizona.edu)**. Feel free to contact him if you believe that there might be an opportunity in your firm for a mathematics major.

DEPARTMENT OF MATHEMATICS

WISH LIST

October 2002

Mathematics East (Newly renovated space)

- **Balcony Commons Area**
  - Railing - $2,000
  - Shade Structure - $2,500
  - Furnishings - $1,000
- **Math (Majors) Center**
  - Scanner - $250
  - Reception Area Framed posters – $500 ($100 each)
  - Commons Room
    - Furnishings & Framed posters - $1,500 ($100 each)
    - Computer - $1,000
  - Reference Room
    - Math materials/publications - $1,000 ($100 each)
    - Computer - $1,000
- **Seminar/Classrooms** - Electronic Blackboard - $2,500

Scholarships

- **Clay Travel Fund** – For graduate travel to meetings - ($400 each)
- **Pierce Memorial Fund** – UG Math Majors - $1,000 ea
- **Lusk Scholarship in Mathematical Sciences** – UG Math Majors - $1,000

Math Teaching Lab

- **Full walls for offices** - $10,000
- **Re-routing Cooling Systems** - $10,000

Mathematics Building

- **Tiered Computer Classroom for Undergrad Courses**
  - Flat panel monitors - $18,000 ($600 each)
  - 30 networked computers - $24,000 ($800 each)
  - Software licenses [Maple, Matlab, MS Office] - $10,000
- **Tiered Computer Classroom for Statistics/Prob/Math Ed Courses**
  - Flat panel monitors - $15,000 ($600 ea)
  - 25 networked computers - $20,000 ($800 ea)
- **Graduate Student Commons Room Furnishings** $1,000 ($100 each)
- **Seminar/Classroom**
  - Electronic Blackboard - $2,500
  - Computer Projection Equipment - $5,000
- **Computer Server Rooms**
  - Raised floor – $15,000
  - Racks - $2,500
- **Total Building** - Network Rewiring to 100BaseT $70,000
- **Seminar/Classroom**
  - Electronic Blackboard - $2,500
  - Computer Projection Equipment - $5,000
- **Faculty Commons Room**
  - Furnishings - $1,000 ($100 each)
  - Whiteboards - $500
- **Staff Commons Room** - Furnishings - $500

Construction of New Space (60,000 sq. ft.) **$20,000,000**

UNDERGRADUATE NEWS

by Bruce Bayly, Associate Head for Undergraduate Programs

There are four hundred or so undergraduates listed as Mathematics majors. Although they have a common academic interest, they have an enormous range of other activities. Many of our students have a second major, finding that their command of Mathematics greatly facilitates the study of a related field, or their first interest may be a related field, and they find that adding the Mathematics major enhances their experience of Physics or Chemical Engineering (for example). Other double majors simply reflect the student's separate interests, such as Math with English Literature or Music. Of course, an outside interest need not be formalized as an educational program, and many of our students indulge their tastes for artwork, sports, etc., in completely informal settings.

Another common feature of our majors is that they tend to be hardworking and talented, otherwise they would not be in our program very long. The result is that both within and outside Mathematics our students distinguish themselves and make us proud of them. In this column I'll highlight recent achievements of some of the Math majors, but I'd like the reader to know that this is just a sample; there's much more going on than I can describe here.

Outstanding Seniors

At every Commencement, each department in the College of Science nominates an Outstanding Senior. In May 2002 the Undergraduate committee chose Ivo Seitenzahl as the Outstanding Senior in Mathematics, in recognition of a long record of very high achievement in both coursework and independent research. Ivo was in fact a triple major (with Physics and Astronomy), and was also named Outstanding Senior in the Physics Department. In addition, he maintained a menagerie of eight exotic frogs in his apartment, confirming his nature as a Mathematician of multiple interests. He is now pursuing graduate study in Cosmology at the University of Chicago.

Biology manifested itself more formally in the work of Cathy Ott, our Outstanding Undergraduate Research Assistant (a new award this year). Cathy had originally intended to be a Microbiology major when she entered the University of Arizona, but soon found that Mathematics suited her better. She maintained her interest in biology throughout, however, and chose the topic of "Colony Dynamics of Bacillus Subtilis" for her undergraduate research project. Math professor Joceline Lega and Biologist Neil Mendelson were Cathy's fortunate faculty mentors. She is now in the graduate program in Statistics at Carnegie-Mellon University.

In addition to our department, two other Outstanding Seniors were also Mathematics majors. Shanna Shaked , also a triple major with Astronomy and Physics, was the outstanding Senior in Astronomy. When not studying, she is an enthusiastic rock climber and swing dancer, though not at the same time. Shanna is now taking some time off between undergraduate and graduate studies, working in the UA Astronomy department. The Outstanding Senior in Biochemistry was our Johanna Schmidtke, currently working on organo-electronic materials as a Gates Fellow at the Cavendish Laboratory of Cambridge University. Johanna's original major was Tuba Performance at Arizona State University, and she occasionally relieves the stress of her serious pursuits by making balloon animals at children's parties.

The foregoing students were all in the College of Science, but we also sponsor an Engineering Mathematics bachelor's degree, and this year our very own Annie Ahnert was named Outstanding Senior in the College of Engineering. Annie was also a finalist for the Freeman, Robie, and Nugent awards. Outside the classroom, she was active in the MathCats club, leading or co-leading most of their activities, and as an undergraduate Engineering Ambassador.

Endowed Scholarship Winners

Not only are we proud of our Mathematics majors when they graduate, we are happy when we can recognize their accomplishments on the way to their degrees, and especially delighted when we can give them money to lighten the financial burden of their University education. A substantial monetary award often enables the student to take on a new opportunity or challenge, either directly by providing necessary funds for travel, textbooks, computer equipment, or indirectly by freeing the student from the necessity to earn the same money at a job.

The funds providing these scholarships and awards are gifts from generous individuals, and words cannot fully describe the positive impact they have. Not only do the recipients themselves benefit from the recognition and the funds which can be used for any purpose at all, but the entire Mathematics community benefits from the confirmation that our educational work is being recognized and valued.

Scholarship nominations are solicited from the faculty at large every Spring, and recipients are chosen by the Undergraduate Committee on the basis of candidates' academic records and personal reports from faculty members. At the Committee's discretion the income from each fund may be either not awarded or divided between several recipients. The number of recipients is kept small, as the intention is to make awards that have a significant impact on the students who receive them. With the same intention, the Committee likes to continue support to students who have received awards in the previous year.

Our longest-standing award is from the **Graesser Memorial Foundation,** named for Roy F. Graesser who was Head of the Mathematics Department in the 1940s and 50s. Art Steinbrenner recalls Graesser as a gentle and considerate individual who lived simply, despite having the means to endow a substantial foundation after his death. Currently the Foundation allocates about $5000 per year of its income to Mathematics scholarships, which is typically divided into ten awards of $500 or so. This year we have three continuing recipients of Graesser scholarships: Laura Baker, Ed Carter, and Noah Snavely. New recipients this year are David Brown, Michael Henry, Becket Hui, Robert Jenkins, Michael Stepp, Anne White, and David Woods.

The next-oldest award is the **Harry W. and Janet Sine Lusk Award**, established by Dr. Duncan Buell in 1985-86. Harry and Janet Lusk graduated from the University of Arizona when it was a very young institution, in 1912 and 1911 respectively. Their three children also graduated from the University of Arizona, making theirs the first family all of whose members were UA graduates. Dr. Buell is a grandson of Harry and Janet Lusk, and continued the tradition by receiving a B.S. in Mathematics from Arizona in 1971. He subsequently received a M.A. from the University of Michigan and a Ph.D. from the University of Illinois, both in Mathematics, and is currently Professor in and Chair of the Department of Computer Science and Engineering at the University of South Carolina.

both within and outside Mathematics our students distinguish themselves and make us proud of them

The Lusk Award was originally given by the College of Science, but Dr. Buell recently decided (to our delight) to put the award exclusively in the hands of Mathematics. This year the Undergraduate Committee made two Lusk awards: one of $400 to Ed Carter in addition to his Graesser award, and one of $1000 to Joshua Green.

The **Peet Memorial Award** was set up in 1992-93 by friends and family of Rick Peet, who had been an undergraduate in the Mathematics Department and, but for his unforeseen death in 1990, would have entered our graduate program. Rick was a typical Math major in that he was also a talented athlete and musician, and he believed deeply in the social value of advanced study in hard science. Michelle Cobeaga is this year's recipient of the Rick Peet scholarship, worth $300.

The **Pierce Award** was endowed by family and friends of our late colleague Richard "Dick" Pierce, who was a member of the Mathematics Department from 1975 – 1990. Dick enriched the lives of his colleagues and graduate students, and especially of the undergraduates in the department. The Pierce award honors Dick's efforts on behalf of our undergraduates; it is worth mentioning that one of our postdoctoral instructorships recognizes his contributions as mentor to numerous young mathematicians. The Pierce award is shared by Althea Moorhead and Shiho Takeda this year.

Our newest award is the **Durward P. and Alice Jackson Award,** which is divided between the Mathematics and Physics departments. Dr. Durward Jackson received his BS in Aerospace Engineering 1964 from the University of Arizona, and subsequently earned a Master of Engineering Administration from the University of Utah and his Ph. D. in Executive Management from the Claremont Graduate University. He is now Professor of Information Systems at the California State University at Los Angeles. The Durward and Alice Jackson provides Math with $1000 per year, which this year is divided amongst Doug Owen, Jennifer Talley, and Mike Urbancic (who was our Jackson recipient last year).

Finally, I would like to mention two of our majors who have received prestigious awards from outside the department. Senior Laura Baker, who has a second major in English Literature, received a Barry M. Goldwater Scholarship. This award honored Laura at the University level, as the UA is only allowed four nominations, as well as at the national level. Her immediate ambition after graduating is to investigate mathematical models of rangeland habitats in southern Africa.

Junior David Brown won 2nd prize for student presentations at the January 2002 AMS-MAA Joint Meeting in San Diego, with a paper on "The Galois group of cyclotomic fields of Fermat primes". A specific application of this work is the construction of the regular 65537-gon using only compass and straightedge. David also received a CATTS (Collaborative Advances in Teaching Technology and Science) Fellowship, which provides a generous stipend to outstanding students with interests in K-12 education in local school districts. In connection with this, David has been spending fifteen hours per week at the Ha:san school, which serves a number of Native American communities. He also plays bass with local rock group Head Pigeon.

MathCats

Another way in which Mathematics undergraduates contribute to the entire University of Arizona community is through the MathCats club. Although it consists of students who enjoy mathematics and take many courses in it, not every member is formally a major in our department. This year's president Kim "K.C." Cochran is in Electrical Engineering, and vice presidents Heather McLaughlin and Kate Sebby are in Biology. The club represents Mathematics nonetheless honorably on campus, and gets up to a variety of activities we are proud to be associated with.

One of the public services the MathCats provide is free tutoring one evening per week. This was especially appreciated last year when we had no space in which to conduct our usual faculty-run tutoring operation. The MathCats also assisted the Math Department's contribution to the College of Science's Homecoming exhibition, helping the general public make PVC flutes and potato-chip-can kaleidoscopes. Moreover, the MathCats had their own triumph at Homecoming, in that then-vice-president Lee Miller was elected Homecoming King. Lee, whose two majors are Mathematics and Engineering Mathematics (these really are two separate majors), represented us with distinction for two solid days of ceremonies.

The MathCats also sponsored intramural volleyball and softball teams and sold Smoothies at Spring Fling. Last but definitely not least, they lent logistical assistance to our celebrations of Mathematics Awareness Week in April, whose theme this year was "Math and the Genome". As part of the events, they filled a pair of crossed clear plastic tubes (representing an X chromosome) with a tangle of yarn (representing a supercoiled DNA molecule), and invited all comers to Guess the Length of the Genome.

All in all, the MathCats offer some of the most serious students at the University a chance to indulge their whimsical sides in the safe company of like-minded individuals. And, not surprisingly, they do so as well as they do everything else, and in so doing make the University a more human place.
Keep it up!

A First Year

by Arlo Caine

"Dear Mr. Caine, We are pleased to..." These are seven words an applicant really enjoys reading after opening a letter from a prospective university. The letters that begin, "We regret..." don't usually finish well. I was quite pleased when I received my letter from the University of Arizona.

After the auspicious opening, the letter continued with an invitation to a recruitment weekend for prospective students. Spanning four days, the workshop brought me and many other applicants to Tucson to meet some of the faculty and students, explore the Tucson surroundings on a department hike, and attend brief seminars exhibiting current areas of research in Pure and Applied Mathematics.

On the hike I was able to witness the unique beauty of the Sonoran desert, including forests of Saguaro Cacti, and other desert plants. The hike peaked on a ridge that overlooked Sabino and Bear Canyons, with a superb vista of the city and surrounding areas. That evening we had the chance to mingle with members of the department at a party at Dr. Grove's home. Meeting some of the professors and their students, I found people generally friendly and outgoing. I was very impressed with the camaraderie between the grad students and faculty. Hence, academically, I could see coming to the Math Department at the U of A.

Given that graduate school in mathematics requires a significant time commitment, it was also important in my decision process to consider the location of a school, "Do I want to live there?" Coming from the San Francisco Bay Area where studio apartments rent for $1000 per month, the relatively lower cost of living in Tucson was too good to be true. The mountains surrounding Tucson provide for plenty of outdoor sports. (After moving to Tucson, I got involved in rock climbing with my friend Jeff, one of my office mates.)

All these factors, along with a good funding offer, added up to my accepting the offer of admission in April and making plans for the move to Tucson.

In May, I received an email out of the blue from Alexander Perlis, a math graduate student at Arizona. Having been at the U of A for several years, he offered to answer any questions I might have, help me find a place to live, even pick me up at the airport if I came to town to visit. Alex and another graduate student, Sacha, let my girlfriend and I stay with them when we came to town in July to look for an apartment. When we moved out here in August, Alex and Sacha even helped us move in. I am indebted to them both for their hospitality and help. It made us feel welcome and part of a community.

Visiting in July gave me the opportunity to fully appreciate the heat of the summer weather in Tucson. People play off the heat with, "well..., it's a dry heat." Dry, wet, whatever, 110 degrees is HOT. Fortunately, the monsoons come during the second part of the summer, bringing the temperature down to about 100 degrees in the late afternoons. The cooling is due to the spectacular thunderstorms that roll in about 3:00 pm every afternoon during this time.

Here at the U of A, math graduate students share office space. A priori, this can be comforting or frightening depending on your personality. If your officemates are rude, sharing an office is obviously not an enjoyable experience. Luckily, I found my officemates to be outgoing, friendly, kind and very helpful. I was fortunate enough to be placed in an office with three fourth year students: Jeff Selden, Tom Hoffman, and Michael Kuecken, who are working in Spectral Geometry, Representation Theory, and Applied Mathematics, respectively. Many times this year, when I struggled to understand a concept, one of my office mates or some of the more senior graduate students, such as Alex, Virgil, Chris, or Aaron, would willingly discuss the ideas with me and help me to resolve my confusion.

I was very impressed with the camaraderie between the grad students and faculty. Hence, academically, I could see coming to the Math Department at the U of A.

I enrolled in the first year core courses in Algebra, Analysis, and Geometry/Topology, along with a single credit course called Research Tutorial Groups (RTG) which was required for first year students. The core courses cover a large amount of material very quickly compared to the pace of an undergraduate course. It really helped that I spent a few weeks before the start of the semester reviewing main topics and results from my undergraduate classes.

In the first semester of the RTG course, three sets of faculty members delivered a series of four lectures each, exposing us to an area of current research. The topics presented to us dealt with quantum computation, symplectic geometry in the study of the moduli space of polygonal linkages in Euclidean space, and a new method for estimation of eigen values of differential operators.

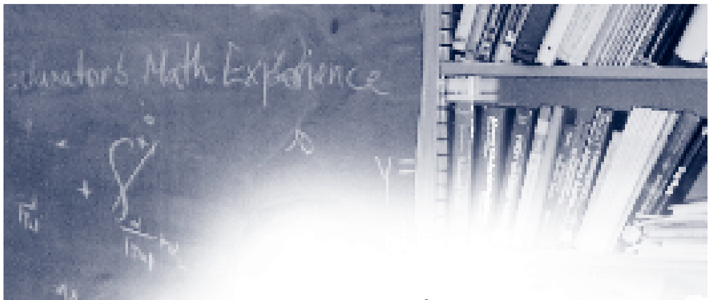
Ideally, each of us would then choose one of the three topics to explore further during our second semester. However, this rule is not set in stone as my second semester RTG took the form of a reading course with Professor Friedlander on Morse Theory and Riemannian Geometry.

I was very impressed by the existence of the Graduate Colloquium, a weekly one hour colloquium with talks given by graduate students to graduate students. Additionally, time permitting, some of the graduate students and faculty meet once a week for the Graduate Tea.

During the four days that the 2002-2003 prospective students visited the U of A, a couple of the prospective students came to the graduate tea on the last day of their stay and sat down next to me. One of the members of the faculty, who had stopped by for a cup of coffee, turned to me and asked if I was enjoying my visit for the weekend. I didn't know quite how to respond, since I had been at the U of A for seven months at that point and, in fact, had encountered him on several occasions. We shared a good laugh after I answered, "Pretty good, since I came here a year ago and decided to stay."

Teaching Postdoc Program – 2002

by Ted Laetsch



During the 2001-02 academic year, we had 12 individuals holding teaching postdoctoral positions. They were: Russel Carlson, David T. Gay, Chris Goff, David Hervas, Pallavi Jayawant, Brigitte Lahme, Bin Lu, Jerry Morris, Bharath Narayanan, Maria Robinson, Valerie Watts, and Stan Yoshinobu. Russel , Pallavi, Bin, Bharath, Maria, and Valerie continued with us for the 2002-2003 year. David T. Gay assumed a research postdoctoral position in the Department; Chris Goff accepted a position as Assistant Professor at the University of the Pacific; Brigitte and Jerry are now Assistant Professors at Sonoma State University, Stan Yoshinobu is an Assistant Professor at California State University, Dominguez Hills.

Teaching Highlights

During the year some of the postdocs were involved with teacher education, such as Math 301 or Math 596E and teacher workshops. This was a great learning experience and helped in their job search process.

Brigitte Lahme taught two semesters of Numerical Analysis with Undergraduate Research Director, Robert Indik. This arrangement had several advantages. It allowed Prof. Lahme to teach two senior level classes and allowed her to observe an experienced teacher on a regular basis. She also found it helpful to be observed on a regular basis, and provided someone with more background knowledge in the subject to answer questions and point out additional issues during the lectures.

In their final semester here, Brigitte also shared in the teaching of Precalculus and of Combinatorics for Secondary Teachers with Jerry Morris. This made it easier to schedule interviews around their classroom obligations, and gave Jerry the opportunity to teach a class for teachers, and a class at the graduate level.

Chris Goff and Carl Lienert (a former postdoc) taught Abstract Algebra and Matrix Analysis together, giving them a chance to teach part of an additional senior level class.

Outreach Highlights

The postdocs found that getting involved in different outreach activities was the highlight of their positions here. It was very beneficial to be able to join already existing programs, such as the summer 2001 Eisenhower AIMS Workshop for high school teachers (Chris, Stan, Jerry, Maria, Brigitte & Bin), and in the 2002 Eisenhower Workshop for middle school teachers (Stan, Valerie, Chris, Pallavi, Jerry, Brigitte, Bin, Russel, and Maria).

Maria, Pallavi, Stan, and Chris gave presentations at a fall in-service for high school teachers, and Brigitte, Jerry, David Hervas, and Maria gave presentations at the spring in–service. Stan worked with regular faculty member Joe Watkins on the Native American Bee Pop Workshop.

They also became involved in several new projects:

- Brigitte worked with a Math Across the Curriculum Inservice (Pueblo HS)
- Maria, Jerrie, and Brigitte developed a new course, Math Sense, for training peer tutors (preceptors) who work in the classroom with students.
- Chris and Carl Lienert worked with the University High School Academic Decathalon team

Other Activities

The Teaching Post Docs become involved in many aspects of the Department and profession.

- Chris, Maria, Pallavi, and Valerie were chosen to participate in the Project NExT program, a professional development program for new faculty sponsored by the Mathematical Association of America.
- Jerry Morris served as Math 120 (Precalculus) coordinator during his two years as a postdoc.
- Several Postdocs served as coordinators of the Undergraduate Teaching Assistant program, which places undergraduates with faculty to assist in teaching courses in such areas as in-class discussions and activities, out-of-class review sessions and assistance, etc.
- Postdocs assisted with the development and review of textbook and support materials for faculty members working with Harvard Consortium Curriculum projects.
- Postdocs serve regularly on the Department's Entry Level and Undergraduate Curriculum Committees.

Faculty Profiles

New Faces

Paul Bressler was born in St.-Petersburg, Russia and immigrated to The United States in 1980 at the age of sixteen. He attended Brandeis University, majoring in mathematics, and in 1989 received his Ph.D. from MIT in pure mathematics (under the direction of Professor Raoul Bott of Harvard University). Since then Bressler has taught at Purdue University, Penn State University, and at The University of Arizona. In addition, he has held several temporary visiting and research positions at Universität Göttingen, M.I.T., Max Plank Institut, I.H.É.S. and Université d'Angers.

Bressler's research interests revolve around the application of homological algebra to problems in analysis and geometry. (Homological algebra is a kind of a modern hi-tech version of linear algebra.) More recently, he has been interested in certain mathematical problems motivated by the current developments in theoretical physics such as strings and quantum field theory. He met his wife Diana soon after she immigrated to The United States from Russia, and they were married in 1992. They have three children.

Yi Hu obtained his Ph.D from MIT in 1991. Since graduation, he has been researching and teaching in several major centers such as the University of Michigan, UC Berkeley, Harvard University, and the University of Texas at Arlington. In addition he is also a frequent visitor of international mathematical institutes such as Max-Planck Institut (Bonn, Germany) and Institut Des Hautes 'Etudes Scientifiques (Bures-sur-Yvette, France).

In 1996, Yi Hu was awarded a Centennial Research Fellowship by the American Mathematical Society in recognition of his contribution to Geometric Invariant Theory and Moduli Problems. Most of his research has been supported by NSF and NSA.

After joining the U of A in 2001, besides participating and organizing the local geometry seminar, he is also co-organizing an upcoming NSF-sponsored conference on the Geometry and Topology of Quotients, to be held in Tucson from December 5 to 8, 2002.

During the last academic year, he was invited to give a talk in a special session of AMS meeting held in Portland. During the summer, he visited and gave lectures at the National Center for Theoretical Sciences of TsingHua University in Taiwan, as well as the Hong Kong University of Science and Technology. In August, he was invited to give a lecture at the International Congress of Mathematics (ICM) satellite conference on Algebraic Geometry held in Shanghai and subsequently attended the ICM in Beijing.

Leonid Kunyansky was born in 1961 in Ukraine, (former USSR, and obtained a Master of Science degree in Mechanics (Fluid and Gas Dynamics) from Kharkov State University, in June 1983. During 1987-1995 he worked at the Kharkov Polytechnic University designing novel tomography algorithms. Building on results obtained during this work, he defended a dissertation for a degree of Candidate of Science in Engineering (equivalent of Ph.D.) at the Kharkov Polytecnhnic Institute in April 1993.

In 1995 he enrolled in the Ph.D. program in Applied Mathematics at Wichita State University to study under the supervision of Prof. P. Kuchment. There, he investigated problems of wave propagation in photonic crystals. He obtained his Ph.D. in Applied Mathematics in August 1998.

After graduation, Kunyansky worked for three years at California Institute of Technology, Department of Applied and Computational Mathematics, as a Postdoctoral Scholar and Lecturer in Applied Mathematics. At Caltech he continued his research on wave propagation, this time with an emphasis on design of state of the art, fast, high-order numerical techniques for the solution of large-scale EM scattering problems.

Since 2001 he has worked as Assistant professor at University of Arizona, continuing research in a general area of wave propagation, electromagnetic and acoustic scattering, photonic crystals, tomography. His other interests include hiking/ backpacking, music, and martial arts.

Peter Wiles did his undergraduate work in mathematics, and entered the PhD program at the University of Wisconsin at Madison with the intention of studying pure mathematics. His interests shifted to mathematics education, which eventually became his primary area of research and topic of dissertation. He came to the University of Arizona to become an active member of the department's mathematics education program.

In mathematics education, Wiles is interested in issues related to teacher development. In particular, he is interested in examining how future teachers develop their knowledge of mathematics in ways that are most useful for their future practice. As such, he has been paying a great deal of attention to the mathematics courses for future elementary teachers. He would like to design methods for engaging these students in such a way that they are reflective about teaching while they are thinking about mathematical concepts. Besides working with pre-service teachers, he is also interested in inservice teachers' professional development. He has facilitated summer workshops, and has also been helping to organize teacher study groups in mathematics during the school year.

Wiles spent much of his early life in Anchorage, Alaska and developed an affinity for skiing as well as hiking and camping. He shares his life in Tucson with Tywana, and her seven year old son, Eric, enjoying outdoor activities and spending time with their dog, Bandersnatch.

Retirees

Steve Willoughby

In May of 2002, Stephen Willoughby retired after serving fifteen years as head of the Mathematics Education group in the Mathematics Department. Steve came to the UA in 1987 from New York University where he held a joint appointment as Professor of Mathematics and Professor of Mathematics Education since 1965.

Under Steve's leadership, the landscape of Mathematics Education has been transformed. Four new faculty members have been hired, a doctoral program in Mathematics Education within the Mathematics Department has been put in place with five students receiving degrees to date, and a new promotion and tenure committee has been created to help traditional P&T committees reward deserving mathematics and science educators. These are just three of the many achievements that mark the tenure of Steve Willoughby. Thanks to him, mathematics education at Arizona now occupies a position of national prominence. Perhaps more importantly, he leaves a program positioned to take the next step—a national leadership role in mathematics education.

As he joins his family as a full-time husband, father and grandfather, Steve leaves a legacy of action, accomplishment, and excellence—and stories. Those who know him have been regaled with his stories many times over. For those who don't know him, his stories and much, much more can be found in his just-published autobiography: ***The Other End of the Log, Memoirs of an Education Rebel.*** But what you won't find from his stories or his book is another legacy—a legacy of generosity. Steve has given his time, his money, and his energy selflessly to the cause of mathematics education in untold amounts. He has used every means at his disposal to advance his cause and his passion—raising the level of mathematical understanding of every student from preschool to graduate school.

And retirement won't stop his efforts. He may not have his office at the University but don't be surprised to see Steve volunteering at an elementary school math class in the near future. Those are the children he most loves to teach.

Marty Greenlee

Marty Greenlee, born in San Diego, received his Ph.D. in Mathematics from the University of Kansas at Lawrence, in 1967. Marty started his teaching career in the U.S. Navy (from which he retired in 1984 with the rank of Commander) and joined our Department in 1971 as an Associate Professor. He was promoted to Full Professor in 1976. From 1991 through 1996 he served as an Associate Head for the Department, and in 1994, he served as acting Head of the Department. In 1996 and 1997 he served as Associate Head for Graduate Studies, and on Marty's watch, our Graduate Program became one of the most highly competitive programs in the country.

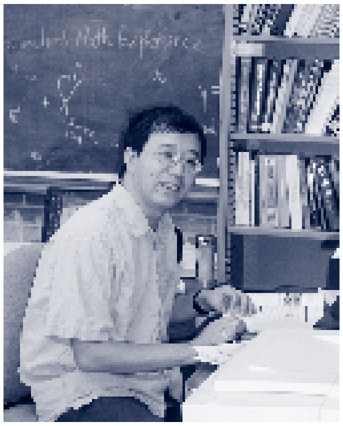
Here in Arizona, he has taught a huge variety of both undergraduate and graduate courses. In the last few years alone, Marty has taught Calculus, Vector Calculus, Ordinary Differential Equations, Analysis for Engineers, Mathematical Modeling, Real Analysis, and Applied Math Principles & Methods.

In addition to teaching, he has contributed his time and efforts to the Department on the Library Committee (chair), Undergraduate Committee, Engineering Mathematics Committee (chair) Promotion and Tenure Committee (chair), the Planning & Steering Committee, Personnel Committee, Graduate Committee (chair). He has chaired ad hoc committees for the College and University, has served on Applied Mathematics Committees, the University Faculty Peer Review Grants Proposal Committee, review committees, and has acted as Graduate Advisor.

He continues to be an active researcher in spectral theory and has studied different problems related to perturbations of eigenvalues for both self-adjoint and non-self-adjoint operators, and his papers have been published in all the leading journals in the field.

Awards

Bin Lu



Bin Lu, a Teaching Post-doc with the Department is this year's Faculty recipient of the Extended University's Summer Teaching Award. Two awards are made each year one to a graduate student and one to a faculty member, with the term "faculty" interpreted to cover visiting, adjunct, and regular faculty. The competition is over the whole University, and this year there were close to 800 nominations. The Office of the Summer Session selected 13 faculty finalists from disciplines as disparate as Organic Chemistry and Poetry, and we are proud to say that this group included another mathematician, **Stéphane LaFortune**, Hanno Rund Visiting Assistant Professor.

The selection committee was impressed by the time and effort Bin devoted to helping his students master the concepts of Vector Calculus, and to the humor and care that he constantly brought to class. Even more, the student nominations spoke of the challenge of the material itself, and the extent to which Bin assisted and encouraged them to rise to the occasion, and how much more they got out of this course than any others they had taken.

MAPPS: A Department Project in which Parents do Mathematics

By David A. Gay

It's a Tuesday evening in March. Parents assemble on the lawn in front of the high school. Everybody is relaxed. You can hear the friendly banter of Spanish and English as the parents solve a problem. They have gathered to do mathematics—as they have done every Tuesday evening for the last several weeks. Tonight's task is to figure out the relationship between the radius and circumference of a circle. But where are the can lids? (And where are the desks?) No puny circles here! The parents are creating monster-sized circles of their own. (No one is sitting down: There are no desks!)

There's a lot of motion. A parent holds one end of a rope and turns in place. Another holds the other end taut while walking in a circle. She counts out loud the steps she takes until she returns to the position where she began the walk. The final number measures the circumference. She hands the rope to a third person and counts out the number of steps from one end of the rope to the other. This number measures the radius. A fourth parent records the pair of numbers—to be examined later along with other similarly created pairs. Other parents watch and wait their turns to create and measure their own circles.

In the background you hear the sounds of traffic. Occasionally, a teenager's car honks to draw the parents' attention away from their task. There's a chuckle in response. But nobody pays much mind. This is serious business. And it's fun.

This is a scene from Geometry for Parents, one of the five Math for Parents Mini-Courses developed by MAPPS—Math and Parents Partnerships in the Southwest. Each mini-course is based on a theme of school mathematics: algebra, geometry, whole numbers, fractions, and data. Each takes place in eight two-hour sessions over the course of two to three months. Sessions build on parents' own intellectual resources— their knowledge and their experience solving problems. In each session parents actively engage themselves in doing mathematics: Parents solve problems cooperatively in groups, use hands-on materials, and communicate results of their investigations to the whole class. The sessions are exciting and enjoyable.

MAPPS Structure and Goals

The Math for Parents Mini-Courses form the centerpiece of MAPPS, a four-year project to involve K-12 parents in school mathematics. The project is funded by the National Science Foundation and administered by the Department of Mathematics at the University of Arizona. Since its beginning in the fall of 1999, MAPPS has been working with Tucson's Sunnyside Unified School District to develop programs to attract parents of K-12 children and engage them as active supporters of good mathematical learning for their children.

These programs:

- provide parents with in-depth experiences with school mathematics and the processes used in teaching and learning it;
- help parents to be aware of what is happening in their children's classrooms; and
- offer parents occasions to take on leadership roles in working with teachers, administrators, and other parents.

In the summer of 2001, the project expanded to include three additional partnerships at locations in the Southwest, in Chandler (AZ), Las Vegas (NM), and San Jose (CA). Each partnership is between an institution of higher education and a consortium of school districts. The model for working with parents developed at Sunnyside is being implemented at these sites. In each location, the goal of MAPPS is that the following occur:

- Parents have incredible experiences learning the mathematics of the schools.
- Parents talk math with their children.
- Parents encourage children in their learning of math.
- Parents are recognized as intellectual assets in the mathematical learning of their children.
- Schools welcome parents to take part in the mathematical learning of their children.
- Eventually, on a larger scale the culture changes and all citizens come to believe that everybody can learn math, that it is worthwhile, and that it can be fun. Above all, they believe math is something everybody does, like breathing in and breathing out.

Three kinds of activities make up the structure of the MAPPS model. Each activity involves a different level of commitment from a parent. In addition to the Math for Parents Mini-Courses described above there are also two-hour, self-contained workshops for all parents and their children, to give them a stimulating and enjoyable experience with a single topic of mathematics, such as multiplication of whole numbers, surface area, number sense, the nature of, or making sense of data; and Leadership development sessions for parents and teachers who will eventually lead workshops and recruit new parents to participate in the programs.

Impact of MAPPS

Parents who have participated in MAPPS activities report that it has positively changed their views of mathematics and of the learning of mathematics. It has changed the dynamics of doing mathematics in the home. It has changed participants' self-image. These changes are especially true for parents involved in one or more of the Math for Parents Mini-Courses.

"I have really enjoyed it. To me that's really strange because I don't like math. I started with an attitude that I don't like math, and this has been a really fun class."

Other parents feel good about being in the course because it helps to build up their own self-confidence.

"When I started, my confidence was way down. I was ashamed of even being here. But now I even enjoy it, I come because I'm open-minded."

Getting parents involved in the mathematical learning of their children is a major goal of the Math for Parents mini-courses. For many parents their involvement has enabled them to help their kids with math.

"[T]he teacher pointed out the other ways that could have been the right answer. So when I work with my son I react like her, asking him 'how else can you see that?' or 'you can do it this way'."

For other parents, involvement in a Math for Parents course has helped to create a community of learners in their households.

"My daughter is proud of me. I know that she wants to do well in school…She thinks, 'my mom is doing this, I got to do something, I have to be good at math too.'"

In some families where a parent has participated in a Math for Parents course, the kids realize that their parents are making a real effort to help them. They recognize that their parents are trying to learn, just as they are. The kids recognize that the whole family is involved in the learning process together. They see that their parents value learning and that they should also value it.

"For me it was like a challenge and it has helped me quite a bit to better myself, to feel more sure of myself and so that my children see that studying is important."

Taking a Math for Parents mini-course also provides parents with links to the mathematics of the schools:

"It has helped me to understand what my daughter is learning at school right now."

As parents experience the mathematics of the schools they also experience new, liberating styles of learning mathematics. For many parents, taking a Math for Parents mini-course gave them new ways of knowing and learning mathematics. This was a powerful, eye-opening experience for them.

"MAPPS has been very different from my previous experience [with math]. I went through my whole life being told how things were and not given any freedom to figure it out on my own. Being able to experiment with blocks (or whatever) is much more interesting."

Many students of mathematics strongly believe that there is only one way to solve a problem. Thus, parents were surprised to learn that this is a myth and that mathematics is a much more flexible—and human—endeavor.

"I'll do it one way and my neighbor does it in a different way," a parent commented, "and it still works. She showed me a way that I would've never thought of. It helps you open up your mind a little bit."

All of the courses use hands-on materials when appropriate. This is a new experience for the parents and they are delighted by this tactile way of learning mathematics.

"The hands-on material has been fantastic, because you can go home and try it out by yourself or with the kids."

Course sessions frequently get parents to solve problems cooperatively, in groups. This is also a new experience for many of the parents—experiencing mathematics as a social activity by working on mathematics with other people. Heretofore, many parents believed that mathematics was a solitary activity, but working in a group allows them to build on everybody's ideas, communicate results with other people (and experience the learning that happens as a consequence and feel one's confidence rise), and share the excitement of new ideas grasped and problems solved.

"You don't feel that you're by yourself trying to figure something out. Everybody has a different perspective on what we're doing so we help each other out figuring out the problems."

Of course, working in groups is a way of adding a social dimension to the doing of mathematics. In addition, we have found that parents simply look forward to getting together with other parents to learn math, just as they might get together with other parents to go bowling or play bridge.

"You meet other people and you get to learn with other grown-ups."

Another parent said,

"It is surprising how enjoyable it is to work together on a problem with adults. I wonder if it is the same with children?"

In the leadership part of MAPPS activities, a few district teachers and administrators also participate. This participation often changes the teacher-parent and the administrator-parent dynamics. A participating principal said,

"Instead of us being the professionals knowing all the answers, we're right in there with the parents, learning together...Usually when you meet with parents it's 'What's my child done? What's his grade?' [With MAPPS] parents get to know me as a person, as someone they can work with."

MAPPS is having an impact on the schools in unexpected ways. A principal of a participating school talks about MAPPS as a vehicle for getting students—especially Latino students—to think about their educational future:

"…the program promotes … an 'untapped resource' in reaching our students… By directly involving parents in more educational experiences with the school, it [is] easier for us to make inroads with our college services… By connecting parents to education we're able to keep education as a priority. We know that within the Latino family structure that many reasons that Latino youth don't go forward in the education system is because of their commitments to the family system. [MAPPS] creates new paradigms within the family about how to look at education."

Materials Development

Another component of MAPPS is the creation of materials that will enable other school districts to establish and operate a parental involvement program along the lines of the model being developed at Sunnyside and being piloted at the other Southwest sites. The Math for Parents Mini-Course materials are part of this effort. In addition to the Mini-Course texts, the set of materials includes guides for running the workshops, a Leadership Handbook for developing parent and teacher leaders, and a Guidebook for overseeing the entire program. These materials will be supplemented with videos showing MAPPS in action. Many of the materials will be available in both Spanish and English, and the National Science Foundation anticipates that all materials will be disseminated nationally after the end of the project.

For more information go to:
http://www.math.arizona.edu/~mapps/

Presentations, Symposia, Workshops

Jim Cushing, Professor, is the main speaker for the Rocky Mountain Mathematics Consortium workshop at the University of Wyoming for 2003. He will also give the plenary address "Dynamical Systems and its Application to Biology" at the National Center for Theoretical Sciences (CTS) in Taiwan, June 24-28, 2003, and has a new book coming out this fall entitled Chaos I Ecology: Experimental Nonlinear Dynamics, *Vol. 1, Series on Theoretical Ecology*, Academic Press (Elsevier), co-authored with R.F. Costantino, B. Dennis, R. Desharnais, and S.M. Henson.

Professor Leonid Friedlander will participate in the Spectral Geometry Program at the Mittag-Leffler Institute in Stockholm, Sweden (December 2002). He is also a co-organizer of The Conference in Spectral Geometry (U.C. San Diego, January 3-5 2003).

Associate Professor, Yi Hu, has been invited to participate and speak in the conference "Combinatorics, Convexity and Algebraic Geometry" to be held at the Mathematisches Forschungsinstitut in Oberwolfach, Germany from January 26-February 1, 2003.

Joceline Lega, Associate Professor, has been invited to speak at the 2003 Clifford Lectures mini-conference on "Theoretical Fluid Mechanics in Biology" to take place at Tulane University, March 23-27, 2003. She will also present invited talks at the Rank Prize mini-symposium on "Orbital Angular Momentum," (Grasmere, English Lake District, May 12-15, 2003); the workshop on "Dynamics and Bifurcations of Patterns in Dissipative Systems" (Colorado State University, May 19-22, 2003); and at a SIAM Dynamical Systems mini-symposium (May 27-31, 2003, Snowbird Utah).

Professor Douglas Ulmer will give seminar talks in November at the CUNY grad center in New York, and at Toulouse in June at the AMS session.

Jan Wehr, Associate Professor, will spend ten days in January, 2003 as a distinguished Faculty Research Fellow at the Texas Institute for Computational and Applied Mathematics (UT Austin).

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